COMPOSITE STRUCTURE DESIGN

NEW INSIGHTS INTO STIFFNESS MATCHING BETWEEN STANDARD AND DOUBLE ANGLE-PLY LAMINATES.

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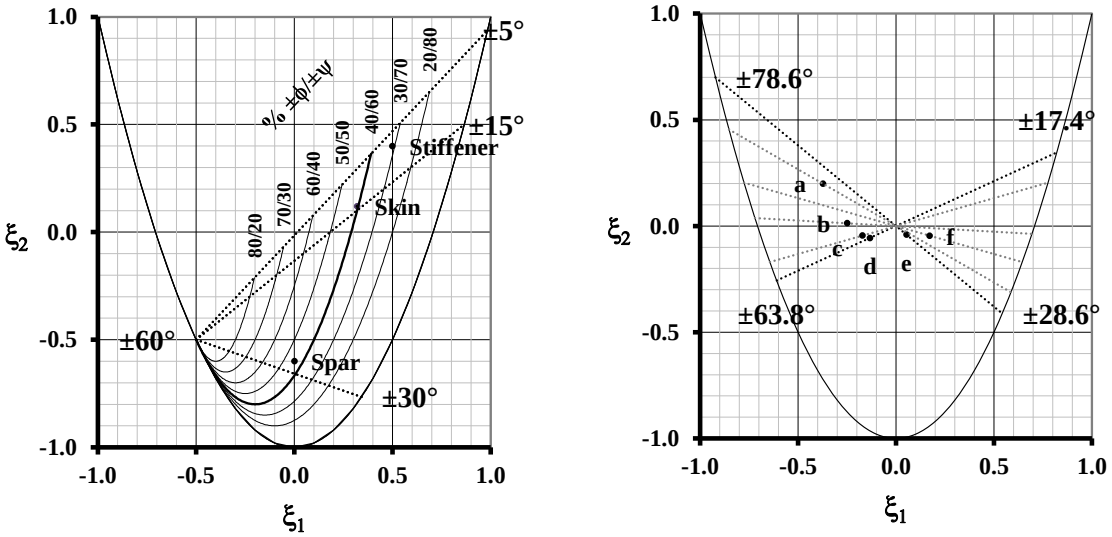
Keywords: Stiffness matching, Double angle-ply, Standard ply laminates, Failure, Buckling.

ABSTRACT

This article presents a methodology for matching bending stiffness between standard ply laminates (with 0°, ±45° and 90° ply orientations) and double angle-ply laminates (with ±ψ and ±ϕ ply orientations). The methodology is only possible through the development of a series of databases containing laminate configuration with specific mechanical coupling characteristics[1], which also account for ply percentages and/or ply contiguity constraints[2].



(a) (b)

Fig 1. *Lamination parameter design space* (ξ_1, ξ_2) *illustrating double angle-ply laminates with stiffness properties matched to standard ply designs in: (a) extension and; (b) bending.*

Figure 1(a) demonstrates that the extensional stiffness requirements for a typical spar and stiffener can be closely matched by adopting the (40/60) ply percentages of a typical wing skin, with ϕ = 60°, and adjusting only the ply orientation, ψ, in the secondary angle-ply sub-laminate to give (±ϕ/±ψ =) ±60°/±5° for the stiffener and ±60°/±30° spar.

Figure 1(b) demonstrates the variation in the in-plane properties (ξ_1, ξ_2) for stiffness matched laminates in bending; here, all possessing bending isotropy.

REFERENCES

1 York, C.B. (2010) A unified approach to the characterization of coupled composite laminates: benchmark configurations and special cases. Journal of Aerospace Engineering, 23(4), pp. 219-242. (doi:10.1061/(ASCE)AS.1943-5525.0000036)

2 York, C. B. and Almeida, S. F. M. (2017) Effect of Design Heuristics on the Compression and Shear Buckling Performance of Infinitely Long Plates With Bending-Twisting Coupling. 21st International Conference on Composite Materials, Xi'an, China, 20-25 Aug 2017.